SW FOREST AND RANGE
EXPERIMENT STATION
JUN 5 1973
STATION LIBRARY COPY

FOREST SERVICE RESEARCH PAPER ITF-16

NOVEMBER 1972

MUST HONDURAS PINE BE WEEDED FREQUENTLY IN PUERTO RICO?

RMD

BY T. F. GEARY AND J. A. ZAMBRANA

INSTITUTE OF TROPICAL FORESTRY

RIO PIEDRAS, PUERTO RICO

FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE

RESUMEN

El desyerbo de plantaciones es un problema económico que podría perjudicar el desarrollo de un programa de siembra de pinos en Puerto Rico. Este estudio fue un paso hacia la determinación de la cantidad mínima de desyerbos que necesita el pino para que tenga una buena sobrevivencia y un ritmo de crecimiento razonable. Fueron estudiados dos sitios: uno en la altura húmeda con suelo granítico y otro con suelo volcánico, ácido, rojo y profundo, ambos típicos de terrenos agrícolas abandonados y recomendados para la repoblación. Los sitios fueron limpiados con machete y rociados con MSMA antes de ser plantados. Las latifoliadas que dominaban algunas áreas fueron cortadas o envenenadas y se prepararon coronas donde el césped era denso, utilizando picotas.

En muchas parcelas no fue necesario desyerbar después de la siembra. En otras parcelas dos limpiezas con machete y una aplicación de MSMA, dentro del período de diecisiete meses desde la siembra, controlaron los yerbajos; mientras que en algunas parcelas cinco limpiezas con machete y dos tratamientos con MSMA, dentro del período de diecisiete meses desde la siembra, no evitaron que los yerbajos sofocaran los pinos.

Recomendamos el desarrollo de un programa de repoblación donde el uso de yerbicidas sea mínimo; identificar sitios donde los pinos puedan competir con los yerbajos y plantar estos con pinos; usar especies de hoja ancha y crecimiento rápido en los sitios donde el crecimiento de los pinos pudiera ser sofocado por crecimiento de yerbajo sin control intensivo.

ABSTRACT

Weeding is an economic problem that could discourage a pine planting program in Puerto Rico. This study was a step towards determining for pine, the least amount of weeding required for good survival and a reasonable rate of growth.

A site in the humid uplands with granitic soil and another with deep, red, acid, volcanic soil, both typical of abandoned farm lands recommended for reforestation, were studied. The sites were cleaned with a machete and sprayed with MSMA before planting; hardwood overstory present in some spots was felled or girdle-poisoned; and coronas were prepared with mattocks where sod was thick.

In many plots no post-planting weeding was required. In other plots, two cleanings with machetes, plus one application of MSMA within seventeen months of planting controlled weeds, while in some plots five cleanings with machetes and two treatments with MSMA within seventeen months of planting did not keep weeds from suppressing pines.

We recommend development of a reforestation program where use of herbicides is minimal; identify sites where pines can compete against weeds and plant these to pines; on sites where weed growth would suppress pine without intensive weed control, use fast-growing, broadleaf species.

MUST HONDURAS PINE BE WEEDED FREQUENTLY IN PUERTO RICO?

by

T. F. Geary and J. A. Zambrana

Institute of Tropical Forestry, Río Piedras, Puerto Rico[1/]

INTRODUCTION

Weed control in the first years of a forest plantation is an important problem in commercial plantation development in Puerto Rico. A general guide (8) to weed control gives the following instructions: Clean planting area free of weeds before planting, then clean three or four times within the first year after planting, two or three times the second year, one or two times the third year, and perhaps once during the fourth or fifth year.

To clean means to make weed free "coronas", circular areas two or three feet in diameter, or "alleys" three or four feet wide. Coronas are suitable for maintenance after planting, while alleys serve for both site preparation and post-planting care. Cleaning is done with machetes or herbicides, or both, depending upon local conditions and individual judgement. It is sometimes recommended, if there is heavy sod, to use a mattock or hoe to scrape a smaller sod-free corona.

Honduras pine, *Pinus caribaea* var. *hondurensis* Barr. & Golf, is recommended for reforestation in Puerto Rico on soils of the plutonic uplands, the so-called granitic soils (1, 3), but a landowner could be discouraged from growing pine by the weeding specified in the general recommendations. Therefore, this study was initiated to determine the least amount of weeding required for good survival and a reasonable rate of growth in newly established plantations.

GENERAL METHODS AND MATERIALS

Two sites representing abandoned farm land were selected (Table 1). One, in the Lago Caonillas basin, was on a typical granitic soil recommended for pine reforestation, while the other, in the Luquillo Experimental Forest, represented the deep, red, acid, volcanic soils of the humid uplands on which Honduras pine has grown well (4). Weeding prior to planting was done with machete and MSMA[2/], 17.7 cc/liter, the cheapest effective herbicide tested by Hadley and Briscoe (5).

The sites, each divided into twelve 35-tree rectangular plots, were planted at 1.8-meter square spacing with bagged planting stock averaging 26 cm tall. Plots were separated by a single row of the same stock and the whole was surrounded by an additional row. The plots were to receive a series of planned treatments. However, substantial modifications were made because of unexpected developments.

[1/] In cooperation with the University of Puerto Rico.

[2/] Monosodium acid methanearsonate.

METHODS AND RESULTS ON GRANITIC SOILS

The granitic site was machete cleaned in October 1968 and MSMA was applied one month later, resulting in good site cleaning (Figure 1). A large *Mangifera indica*[3/] covering most of one plot was injected with herbicide. Planting was done the end of November, two weeks after MSMA treatment. Three plots were machete-cleaned four months after planting, and one month later MSMA was applied to them (Figure 2). This was the only post-planting weeding done, because it was apparent that almost everywhere the pines were outgrowing the weeds (Figures 3, 4, and 5). The principal weed was *Melinis minutiflora*, but *Andropogon bicornis* and *Psidium guajaba* were also prominent. Only under the *Mangifera* and at the edges next to woodland did weeds, led by *Ipomoea* spp., suppress the pines (Figures 5 and 6). An added problem under the *Mangifera* was that pine seedlings were broken by falling limbs.

In August 1970, twenty-one months after planting, survival and average height of the pines, excluding the *Mangifera* area, were 96% and 2.4 meters. There was no statistically significant difference at the 5% confidence level between the three plots receiving the after-planting cleaning and the uncleaned plots.

[3/] See table 3 for common names and authors of the scientific names.

Table 1.--Description of the experimental sites.

Characteristics	Granitic site[1/]	Volcanic site
Soil series	Non-designated clay loam	Los Guineos silty clay loam
Soil origin	Residual from quartz diorite and granodiorite	Residual from basic volcanic rock
Soil classification[2/]	Between Typic Dystropept and Dystropeptic Tropudult	Epiaquic Tropohumult
Ecological life zone (6)	Subtropical Wet	Subtropical Wet
Average Slope	60%	20%
Elevation a.s.l.	430 meters	540 meters
Mean Annual Rainfall	1880-2490 mm	2475 mm

1/ Mr. Bartolomé Rullán Rivera of Barrio Viví Arriba, Utuado, kindly provided the land.

2/ By the 7th Approximation of a Comprehensive System of Soil Classification of the International Society of Soil Science.

Figure 1. – Granitic site 0.5 month after planting. The site was machete cleaned 2.1 months earlier and MSMA was applied 0.9 months earlier.

Figure 2. – Granitic site 6.6 months after planting. The foreground was machete cleaned 2.6 months earlier and MSMA was applied 1.6 months earlier. The background wasn't weeded after planting.

Figure 3. – Granitic site 6.6 months after planting. Pine growing through several grasses and *Psidium* in a plot unweeded after planting.

Figure 4. – Granitic site 9.4 months after planting. Pine growing through *Melinis* and *Andropogon* in a plot unweeded after planting.

Figure 5. – Granitic site 19.7 months after planting. Pines outgrew the competition except beneath the dead *Mangifera* and along the lower edge adjacent to woodland.

Figure 6. – Granitic site 6.6 months after planting. This pine was one of few in the area beneath the *Mangifera* that wasn't completely covered by *Ipomoea* vines.

METHODS AND RESULTS ON VOLCANIC SOIL

The volcanic site was machete cleaned and treated with MSMA the first four days of October 1968 and planted October 21. Where ground cover was thick, coronas were made with a mattock (Figure 7). All plots but one were dominated by grasses before weeding. Because of space limitations one plot of treatment A was located on land covered with citrus, coffee and young regrowth hardwoods. These were either felled or killed by herbicide injection.

The post-planting treatments are listed in Table 2. Use of MSMA was discontinued after a second round of post-planting weedings, because it appeared it was not killing weeds. During the course of the trial, Muñoz and Hill (9) found atrazine[4/] controlled weeds on a similar site and was non-toxic to pine. We used this chemical at a rate of 7.4 kg/hectare and it was very effective. Thirty-eight months after planting (seventeen months after atrazine application) all plots except the one that had had the hardwood overstory needed no further weeding. Because of considerable variation in treatment effects from replication to replication the results in individual plots are emphasized rather than average treatment effects.

4/ 2-chloro 4-ethylamino 6-isopropylamino S-triazine.

Table 2.--Treatments applied to plots on volcanic soil.

Months after planting	Operation	Treatments			
		A	B	C	D
0.9	Machete	+			
0.9	MSMA	+			
4.0	Machete	+	+		
4.9	MSMA	+	+		
7.3	Machete	+		+	
11.3	Machete	+	+		+
17.1	Machete	+			
20.8	Machete	+	+	+	+
21.9	Atrazine	+	+	+	+

Figure 7. – Volcanic site 0.5 month after planting. This plot was carpeted with *Centella* and sod-free coronas were made in it 1.1 months earlier.

Figure 8. – Volcanic site 0.5 month after planting. This plot quickly became covered with tall grasses. *Pennisetum* was resprouting 1.1 months after the pre-planting weeding.

Figure 9. – Volcanic site 9.6 months after planting. Treatment A plot on lower slope 2.3 months after the third post-planting cleaning. Few pines were ahead of the weeds, of which *Panicum*, *Eriochloa*, and *Urena* were prominent.

Figure 10. – Volcanic site 20.8 months after planting. Same plot as figure 9. Many pines were deformed by the heavy cover of *Panicum* and *Eriochloa* removed a week earlier in a fifth cleaning.

A very clean site resulted from the pre-planting treatment. However, on the lower slope, a heavy, tall cover of *Panicum purpurascens, Eriochloa polystachya* and *Pennisetum purpureum* developed quickly on three plots and the pines could not compete against this (Figures 8 and 9). Even five post-planting cleanings with machete and two applications of MSMA during the first seventeen months after planting barely prevented complete loss of the pines (Figure 10). The atrazine treatment salvaged the lower slope plots of treatments A and C, and growth of the surviving 38% of the trees was good (3.7 meters average height thirty-eight months after planting). The lower slope plot of treatment D, which was not weeded until almost a year after planting, was a complete failure (Figure 11).

The majority of plots were characterized by much lighter grass cover during the first few months after planting. *Andropogon* was common and several plots were carpeted with *Centella asiatica,* an indicator of very wet soil (Figure 7). Two cleanings with machetes and one application of MSMA within seventeen months after planting (treatment B) was sufficient to control weeds (Figures 12 and 13). Growth in these upper plots of treatment B was very good (5.4 meters height in thirty-eight months). In plots receiving less weed control *Pennisetum* developed heavily (Figure 12), and the pines in these plots might well have failed without the release by atrazine. However, survival was excellent (92%) in the upper slope plots of treatments C and D, for the atrazine was applied in time.

Weed development in the plot of treatment A in the former hardwood area was completely different from the other plots (Figures 14 and 15). Predominant were *Ipomoea* spp., *Urena* spp., *Solanum torvum, Lantana camara,* and *Eupatorium odoratum.* The plot was cleaned five times with machete and sprayed twice with MSMA after planting in the first seventeen months and still the pines were overcome by weeds. Falling branches from dead overstory trees also damaged pines. The plot was salvaged by atrazine, but several trees were already badly deformed (Figure 16) and about one third of the trees needed release from *Ipomoea* again thirty-eight months after planting.

CONCLUSIONS AND DISCUSSION

For sites cleaned well and treated with MSMA before planting, we found that the amount of post-planting weeding required fell into three categories:

1. No weeding was required, for the pines outgrew the weeds.

2. Two cleanings with machetes plus one application of MSMA within the first year was sufficient for good survival and growth.

3. Five cleanings with machete plus two treatments with MSMA within seventeen months of planting did not keep weeds from suppressing the pines.

These results, plus our experience with other pine plantings in Puerto Rico, lead us to believe that Honduras pine can be planted on many sites with little or no post-planting weeding. Although we used MSMA in this study, we believe we could often obtain similar results without a herbicide. In fact, field reports questioned whether MSMA was killing weeds.

Figure 11. – Volcanic site 9.6 months after planting. Pines in one plot of treatment D were killed by a dense stand of *Pennisetum* (masked by edge cover of *Neuroloena).* Man in center shows weed height.

Figure 12. – Volcanic site 12.7 months after planting. Treatment B plot (front) was cleaned 1.4 months earlier and treatment C plot (rear) was cleaned 5.4 months earlier. B still had a ground cover of *Centella,* while *Pennisetum* had developed heavily in C.

Figure 13. – Volcanic site 17.1 months after planting. *Pennisetum* did not develop in this plot of treatment B, which was last cleaned 6 months earlier.

Figure 14. – Volcanic site 4.3 months after planting. This plot had an overstory of hardwoods and received treatment A. It was last cleaned 0.3 month earlier.

Figure 15. – Volcanic site 9.6 months after planting. Same plot as figure 14, 2.3 months after the third cleaning. *Ipomoea* was the dominant weedd.

Figure 16. – Volcanic site 17.1 months after planting. Same plot as figures 14 and 15, 0.2 month after the fifth cleaning. Several pines were deformed by weeds and falling limbs.

This is a favorable prospect for reasons other than economic. A justification for tree planting is soil conservation, so that minimal exposure of the soil is desirable. Moreover, use of herbicides presents hazards, because in Puerto Rico planting areas generally are close to other agricultural activities, water supplies, and population centers. We prefer to lose some extra growth that might be achieved by intensive weed control in return for increased environmental protection. For this reason and others, it is to be questioned whether we should rely heavily on herbicides in forestry practice.

Ewel (2) found in the Subtropical Wet Forest (6) of the Luquillo Experimental Forest that 100 times more energy was required to arrest succession with a herbicide than with men using machetes. Although dollar costs were about equal, this energy consumption with herbicides is inconsistent with conservation.

However, there are sites in which intensive weed control treatments will be required to grow pine; sites with a hardwood overstory fall into this class. It can be questioned if these sites should be planted to pine. Basically this is the argument of Lamb (7) who concluded that it is too expensive to grow pine on sites cleared of high forest in the humid lowland tropics. This is supported by Ewel (2), who calculated that a minimum of 10 man hours a hectare is needed to arrest succession with herbicides in the first year on a site cleaned of hardwood overstory in a Subtropical Wet Forest, and a minimum of 100 man hours, and up to 500 man hours are required without herbicides.

A hardwood overstory presents two weed control problems. The first is the difficult task of removing it. Trees can be girdled or poisoned, but large, standing, dead trees are hazards to pines and people, and felling and windrowing are very expensive. The second is the intensity of weed control that will be needed after planting. Therefore, if abandoned cleared land is available it seems urgent to plant it to pine before it reverts to hardwood cover. Abandoned pasture and exhausted crop land seem ecologically similar to the savanna grassland sites within the humid lowland tropics which have proven suitable for pine (7).

It would be useful to be able to predict the potential weed competition on abandoned cleared land. For example, if competition like that in figure 9 were predictable, then one might select for planting a fast-growing broadleaf like kadam, *Anthocephalus chinesis* Rich, which could suppress weeds. That is, the reforestation species chosen for planting on a site should be one for which adaptation and competition stresses would both be intermediate, so that total stress on the species would be a minimum (2).

Comparative research data are limited for identifying potential weed problems on various sites in Puerto Rico, but there are leads. The granitic soil, except for the hardwood area, and the majority of plots on the volcanic soil were initially characterized by many clumps of *Andropogon.* These plots did not require intensive weed control, and thus *Andropogon* might be an indicator of a favorable planting site for pine. Pine competed easily on a site dominated by *Melinis,* but it could not compete against *Panicum, Eriochloa* and *Pennisetum.*

Atrazine, effective in releasing pines from intense weed competition, might be used to salvage a plantation if a program of minimal weed control has failed. However, a conservative approach should be considered in these cases. Evenly distributed losses of 10 to 15% of the seedlings appear to be tolerable at 2.7 meter square spacing and, therefore, intensive control might be applied only to spots rather than the whole plantation.

This study was not designed as a comparative test of herbicides; standard prescriptions were followed. Therefore, the results should not be interpreted as negative towards MSMA. In fact, *Pennisetum* did not develop in any plot on volcanic soil receiving a post-planting application of MSMA, whereas elsewhere it developed strongly.

Table 3.--Author references and common names of weeds mentioned in text.

Scientific name	Common name in Puerto Rico (10)
Andropogon bicornis L.	matojo de techar; barbas de indio
Centella asiatica (L.) Urban	yerba de chavo
Eriochloa polystachya H.B.K.	malojilla
Eupatorium (Osmia) odoratum L. Syst.	santa maría
Ipomoea tileacea (Willd.) Choisy and *Ipomoea rubra* (Vahl.) Millsp.	bejuco de puerco
Lantana camara L.	cariaquillo
Mangifera indica L.	mangó
Melinis minutiflora Beauv.	yaraguá, yerba melado
Neuroloena lobata (L.) R. Br.	sepí
Panicum purpurascens Raddi	malojillo
Pennisetum purpureum Shumach	yerba "merker"; yerba elefante
Psidium guajaba L.	guayaba
Solanum torvum Sw.	berenjena cimarrona
Urena lobata L. and *Urena trilobata* Vell.	cadillo

LITERATURE CITED

(1) Briscoe, C. B. y Marrero, J.
1962. La repoblación forestal en las tierras arenosas de Puerto Rico. Revista de Agricultura de Puerto Rico 49:129-136.

(2) Ewel, J. J.
1971. Experiments in arresting succession with cutting and herbicides in five tropical environments. Ph. D. Dissertation, University of North Carolina, Chapel Hill. 248 pp.

(3) Geary, T. F. and Briscoe, C. B.
1972. Tree species for plantations in the granitic uplands of Puerto Rico. USDA Forest Service Research Paper ITF-14.

(4) _____ and Zambrana, J. A.
1972. Comparative adaptability of conifers in Puerto Rico, p 226-234. In J. Burley and D. G. Nikles, (ed.), Selection and breeding to improve some tropical conifers. Volume One. Commonwealth Forestry Institute, Oxford, England.

(5) Hadley, H. H. and Briscoe, C. B.
1966. Herbicides for forest plantations--1966. USDA Forest Service Research Note ITF-6.

(6) Holdridge, L. R.
1967. Life Zone Ecology. Tropical Science Center, San José, Costa Rica. 206 p.

(7) Lamb, A. F. A.
1967. Artificial regeneration within the humid lowland tropical forest. Report of the first session, FAO Committee on Forest Development in the Tropics, Rome, Italy, October 1967, pp. 73-86.

(8) Muñoz, J. E. y Angleró, J. I.
1968. La repoblación forestal en Puerto Rico. Servicio de Extensión Agrícola, Universidad de Puerto Rico, Río Piedras. 13 pp.

(9) Muñoz, J. E. and Hill, L. W.
Atrazine effectively controls hardwood weeds in Honduras pine plantations. USDA Forest Service Research Note. (In press).

(10) Otero, J. I., Toro, R. A., and Pagán de Otero, Lydia.
1945. Catálogo de los nombres vulgares y científicos de algunas plantas puertorriqueñas (Segunda Edición). Universidad de Puerto Rico, Estación Experimental Agrícola, Río Piedras, Boletín Núm. 37. 281 pp.

PESTICIDE PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key – out of the reach of children and animals – and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to be sure the intended use is still registered.